# Space Weather Technical Forecast

Issued on Thursday, 23 May 2024 at 01:27 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

## Space Weather Forecast Headline: Isolated M-class flares likely throughout. Slight chance G1 Minor Storm days 2-3 (24-25 May) from CH39/- fast wind arrival.

## Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** The activity was Moderate, with the largest flare of the period a M2.3 flare at 22/0404 UTC from AR3683, which is now on the far side. There are currently seven sunspot regions on the visible disc. M1.5 and M1.2 flares were also observed from AR3679, at 22/0313 UTC and 22/1405 UTC respectively. AR3685 also contributed high level C-class flares, with the overall background flux of the Sun steady within C-class levels. There are currently seven sunspot regions on the disc. The largest and most magnetically complex is AR3679 in the southwest, which is currently classified as beta-gamma-delta. The other large spot is AR3685 is now in the southwest quadrant, and has shown slight increase in size and magnetic complexity, and is currently classified as Ehi/beta-gamma. AR3685 and AR3689 both also have beta-gamma configurations, having shown slight increase in area or spot number and magnetic complexity.
Various CME's were observed in imagery, and none are currently expected to be Earth-directed. However, a recent partial filament liftoff in the southeast quadrant has generated a CME, which will be analysed once more imagery is available, although the CME is thought unlikely to be Earth directed.

**Solar Wind / Geomagnetic Activity:** Solar winds observed by ACE at L1 have been indicative of ongoing slow wind conditions. The solar wind speed started and ended the day close to 400 km/s, peaking at 428 km/s at 22/0319 UTC, declining in-between to around 330 km/s. Density remained below average. The Interplanetary Magnetic Field (IMF), Bt, was been predominantly weak, briefly peaking at moderate levels of 9 nT around 22/1900 UTC. The north-south component, Bz, favoured a positive (northward) orientation, although did temporarily become negative at times in the evening, reaching -2 nT at 22/2154 UTC. Phi angle was mainly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

**Energetic Particles / Solar Radiation:** High energy proton flux (greater than 10 MeV) remained at background levels. High energy electron flux (greater than 2MeV) observed by GOES-16 was mainly Moderate, with a peak of 267 pfu. The associated 24-hour fluence has remained below the Active threshold, with a decreasing trend. Observed fluence at 23/0000 UTC was 7.12e6 integrated pfu.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Moderate activity is likely to continue with isolated M-flares possible each day, and a slight chance of rising to High due to any X-class flares. These are most likely from AR3679, also AR3685 and AR3689. Ex-AR3663 and Ex-AR3666 are also anticipated to return to the northeast limb from late tomorrow onwards (24th May). However, it is uncertain how much of these regions have survived their transit across the far-side.

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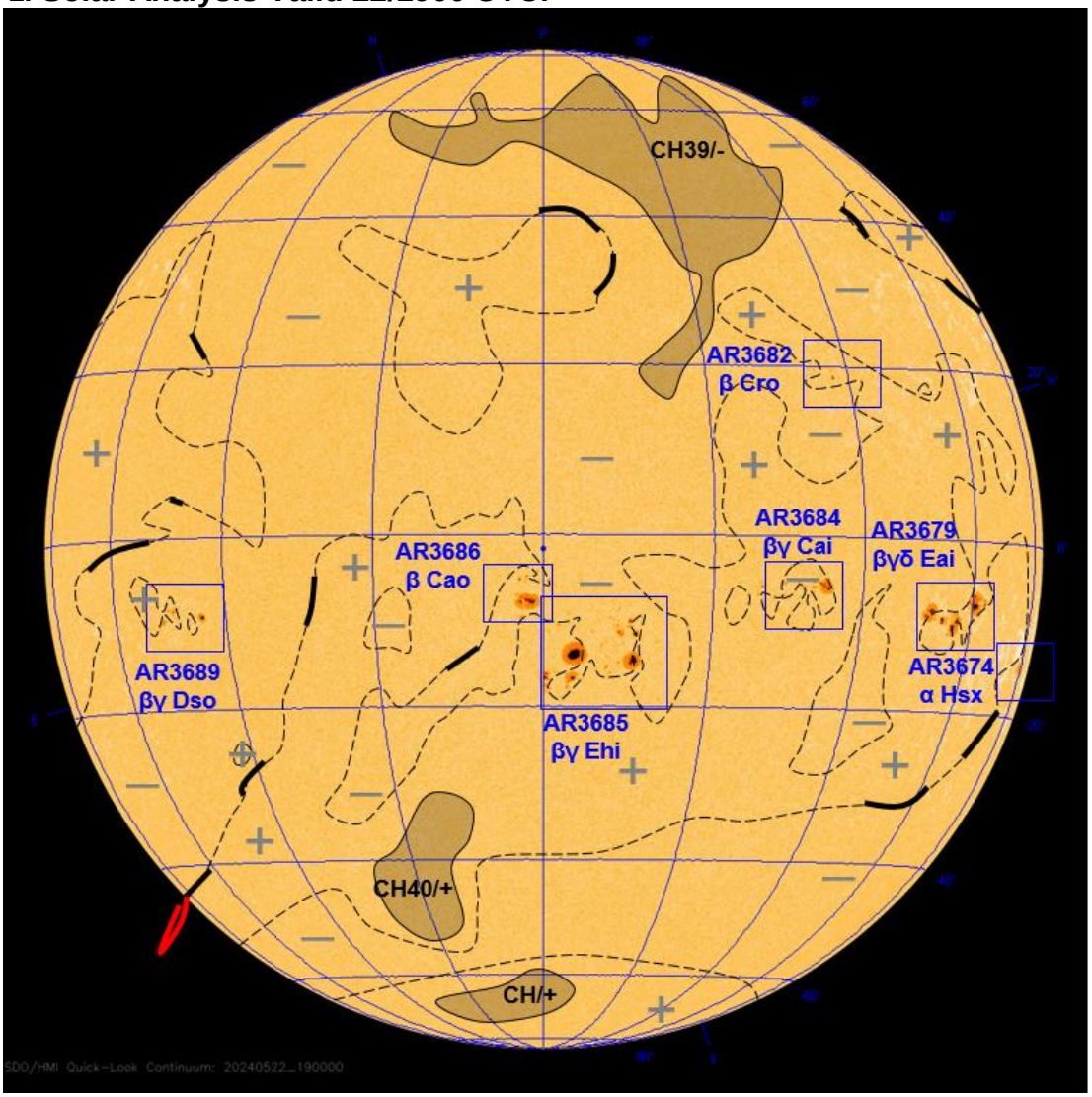
# Met Office Space Weather Technical Forecast

**Solar Wind / Geomagnetic Activity:** There are no Earth directed CMEs currently expected. Slightly elevated to background solar winds are expected to persist today and tomorrow (24-25 May), before the onset of any fast wind enhancement from the southward extension of northern hemisphere CH39/-. The strength and timing of any enhancement is low confidence. Mainly Quiet (Kp 0-2) activity is expected with only isolated Unsettled (Kp 3) intervals, but likely rising to Active (Kp 4) with a slight chance of G1/Minor Storm (Kp 5) intervals from any coronal hole enhancement, most likely day 3 (25 May). Later day 4 (26th) any HSS influence is expected to wane.

**Energetic Particles / Solar Radiation:** High energy proton flux is expected to persist at background levels, but with a chance of enhancement given any strong flares from the regions in the southwest quadrant. High energy electron flux is forecast to remain at Low to Moderate levels initially, increasing to predominantly Moderate from day 3 (25th). However the associated 24 hour fluence is expected to remain below the Active threshold.

**Figure 1. Solar Analysis Valid 22/1900 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

Solar winds are currently slightly elevated to background and expected to persist at this level until the onset of the next fast wind enhancement, likely from CH39/- late tomorrow (24 May) or early day 3 (25 May). This is a large northern hemisphere feature, with a narrow southern extension into the solar mid-latitudes, and was not present on the previous rotation. Coupled with the disfavoured time of year for strong connections to coronal hole fast winds (Russel-McPherron effect), and the limited response currently featured in the MOSWOC Enlil model, a significant geomagnetic response to any HSS is considered unlikely.

Any HSS enhancement is likely to reach 450-500 km/s at the strongest, with any negative (southward) IMF then bringing the likelihood of Active geomagnetic intervals from late tomorrow (24 May), with a slight chance of G1/Minor geomagnetic storms (Kp 5) day 3 (25 May). Otherwise, mainly Quiet (Kp 0-2) conditions expected with a chance of isolated Unsettled (Kp 3) intervals.
Various CME's were observed in imagery, and none are currently expected to be Earth-directed. However, a recent partial filament liftoff in the southeast quadrant has generated a CME, which will be analysed once more imagery is available, although the CME is thought unlikely to be Earth directed.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 5 | 20 | 5 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Figure 2: Met Office Enlil model

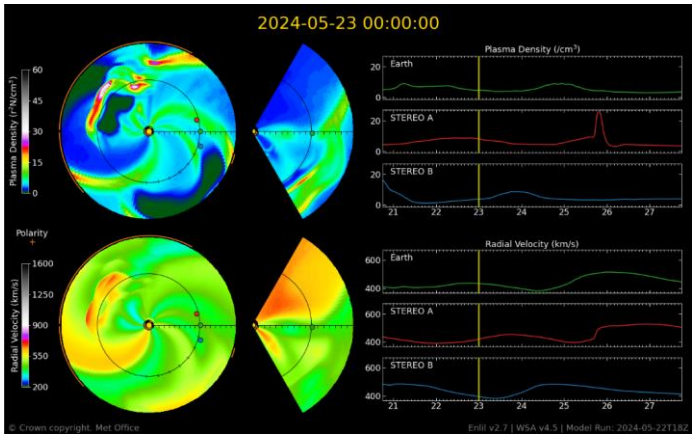


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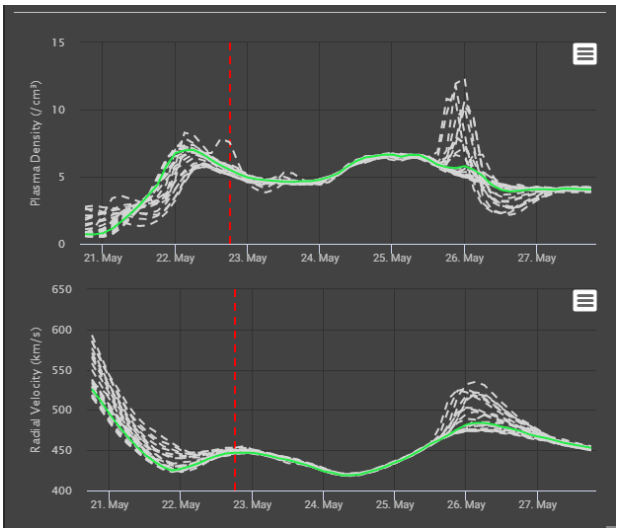
**Figure 3: Met Office Enlil ensemble – with an indication of the possibility of a slight glancing blow from a CME (which left the Sun on the 22nd from a filament eruption in the northwest) arriving late on the 25th.**




## Radio Blackouts - X-Ray Flares:

There are eight sunspot regions on the disc. Most notable is AR3679 in the southwest, which has maintained a small delta-configuration to the north of its leader. Its trailer spots, consisting of a further bipolar pair, also show some very slightly mixed polarities within their local intermediate region. The other larger spot is AR3685 nearing the south-centre disc, however this appears to be a mature region with little ongoing development, beyond the emergence of a small bipolar pair of spots on its southern periphery. The other regions are currently smaller, simpler and largely stable.

Ex-AR3663 and Ex-AR3666 are also anticipated to return to the northeast limb from late tomorrow onwards (24th May). However, it is uncertain how much of these regions have survived their transit across the far-side.

Moderate activity is likely to continue with further isolated M-flares possible, with a slight chance of an isolated X-class flare. These most likely from developing AR3679 or AR3685 and AR3689, plus later in the period the returning regions.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 70 | 60 | 55 | 50 |
| Very Active | R3 to R5 X Class | No | 10 | 5 | 5 | 1 |

## Solar Radiation Storms - (High Energy Protons):

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High energy proton flux is expected to persist at background levels, but with a chance of enhancement given any strong flares from the regions in the southwest quadrant, this most likely from AR3679 before it rotates off behind the west limb later in the forecast period.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 20 | 20 | 10 | 10 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

## High Energy Electrons Event (≥ 2MeV):

High energy flux, as observed by GOES-16, has been on a downward trend and is forecast to remain at Low to Moderate levels initially with a continuing downward trend. Flux levels are expected to increase to predominantly Moderate from day 3 (25th) onwards under the influence of any HSS from CH39. However, the associated 24 hour fluence is expected to remain below the Active threshold, despite a probable slight upward trend in the fluence late in the forecast period.

Therefore MOSWOC REFM is thought to be giving good guidance.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 1 | 5 | 10 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 4: Met Office REFM model**

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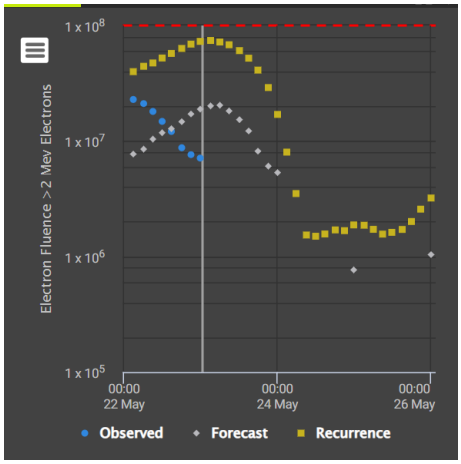


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